Astrophysical Indication for Asteroid Mass Black Holes and New Search Strategies

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White Dwarfs in Dwarf Spheroidal Galaxies: A New Class of Compact-Dark-Matter Detectors

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GravNet Meeting
Mainz: 27/06/25

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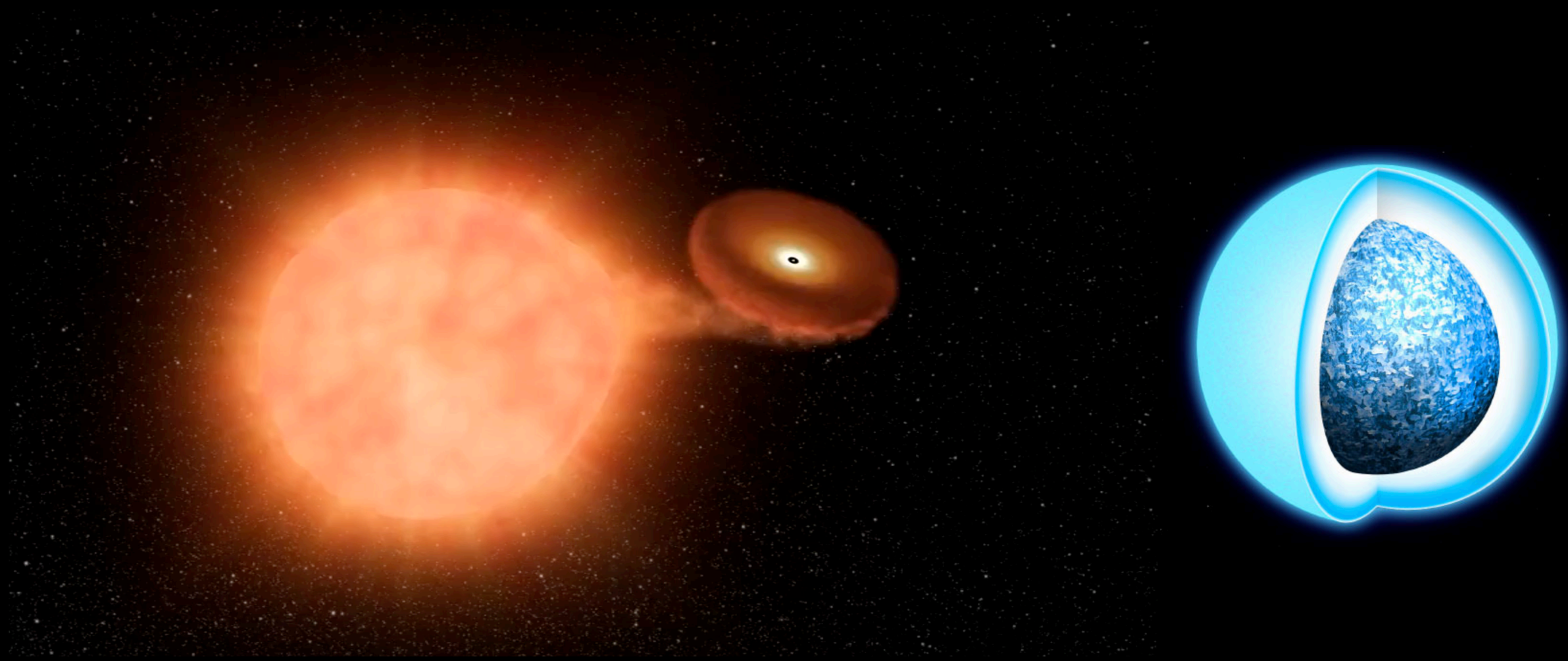
Johnathan Tinsley, Monika D'Onforio, Gianluigi Case

ZTF observes unusual events

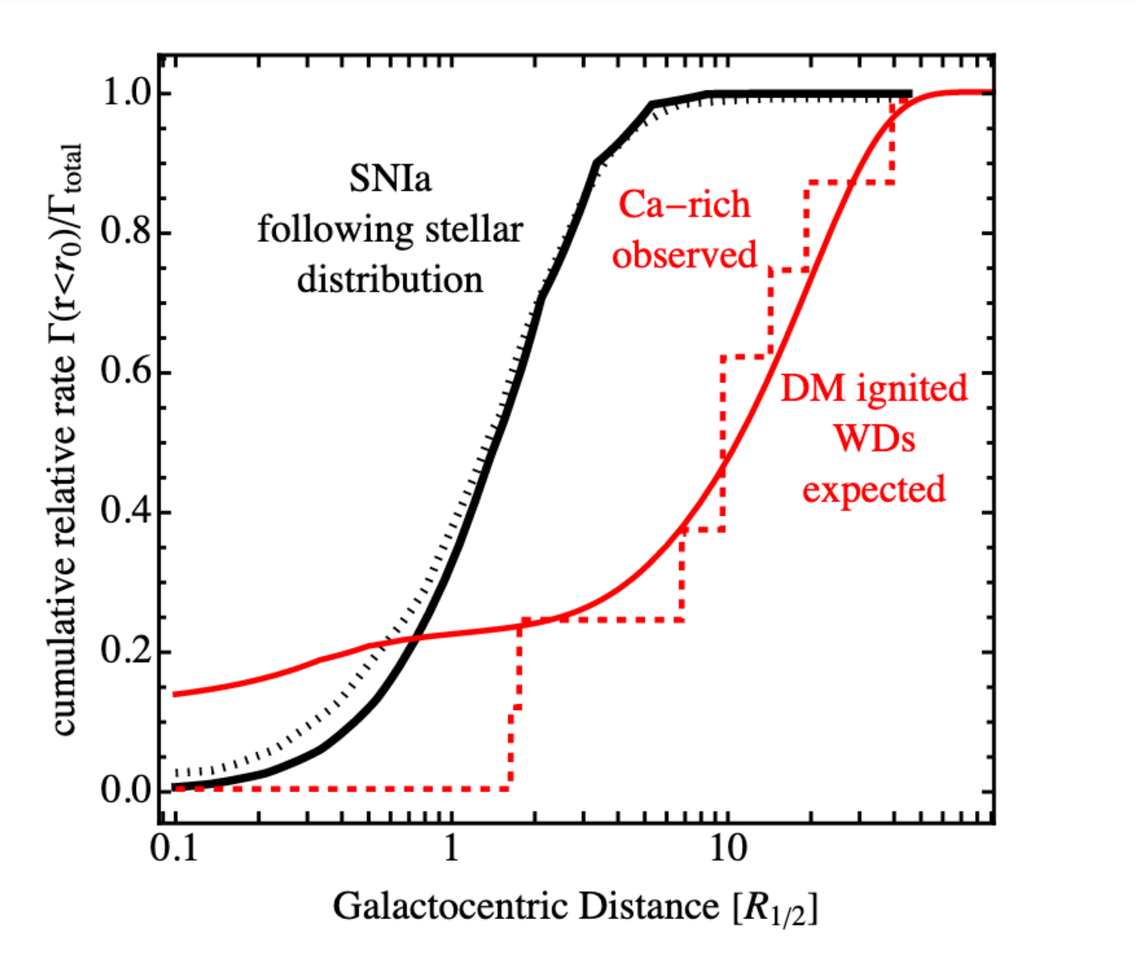
Juri Smirnov, juri.smirnov@liverpool.ac.uk; Panda-X meeting, 10/04/25

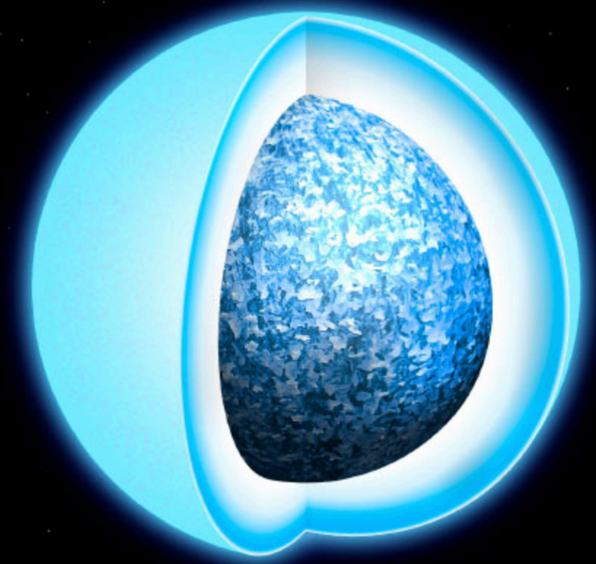
Ca-Rich Gap Transients



https://exoplanets.nasa.gov/resources/2172/type-ia-supernova/

Ca-Rich Gap Transients

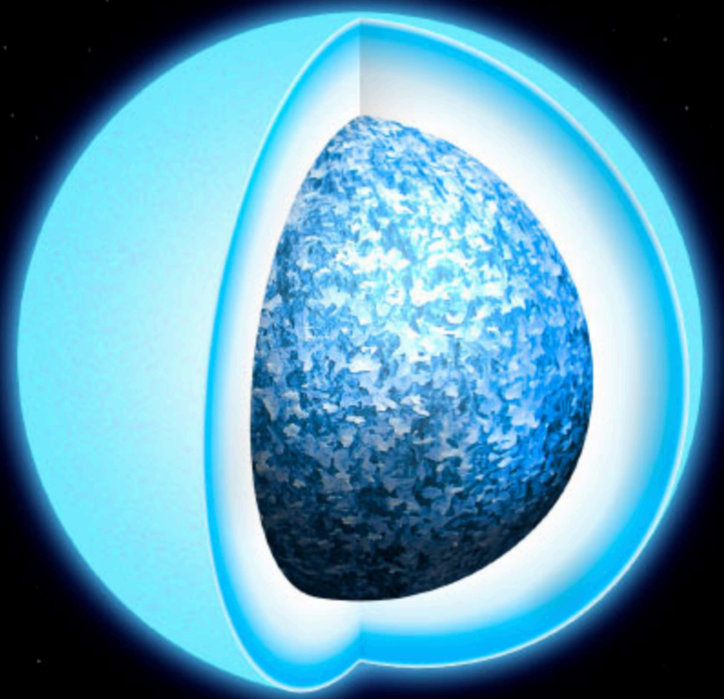




2211.00013 : **JS**, Goobar, Linden, Mörtsell

New Ignition Mechanism

Dark Matter Triggered Supernova

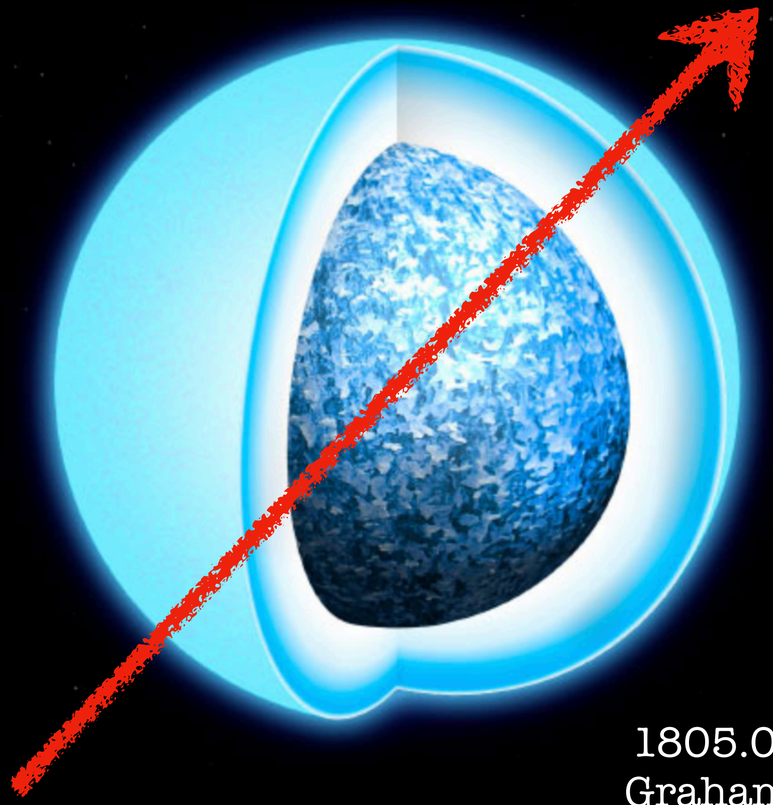


1805.07381:
Graham et al.

Dark Matter Triggered Supernova

$$T > \mathrm{MeV}$$

$$\frac{\lambda_{\rm min}}{\rm cm} = \begin{cases} 2.8 \times 10^{-5} \sqrt{\frac{5 \times 10^9 \frac{\rm g}{\rm cm^3}}{\rho_{\rm WD}}}, & \frac{\rho_{\rm WD}}{\rm g/cm^3} > 1.6 \times 10^8 \\ 10^{-4} \left(\frac{2 \times 10^8 \frac{\rm g}{\rm cm^3}}{\rho_{\rm WD}} \right)^2, & \frac{\rho_{\rm WD}}{\rm g/cm^3} < 1.6 \times 10^8 \end{cases}$$



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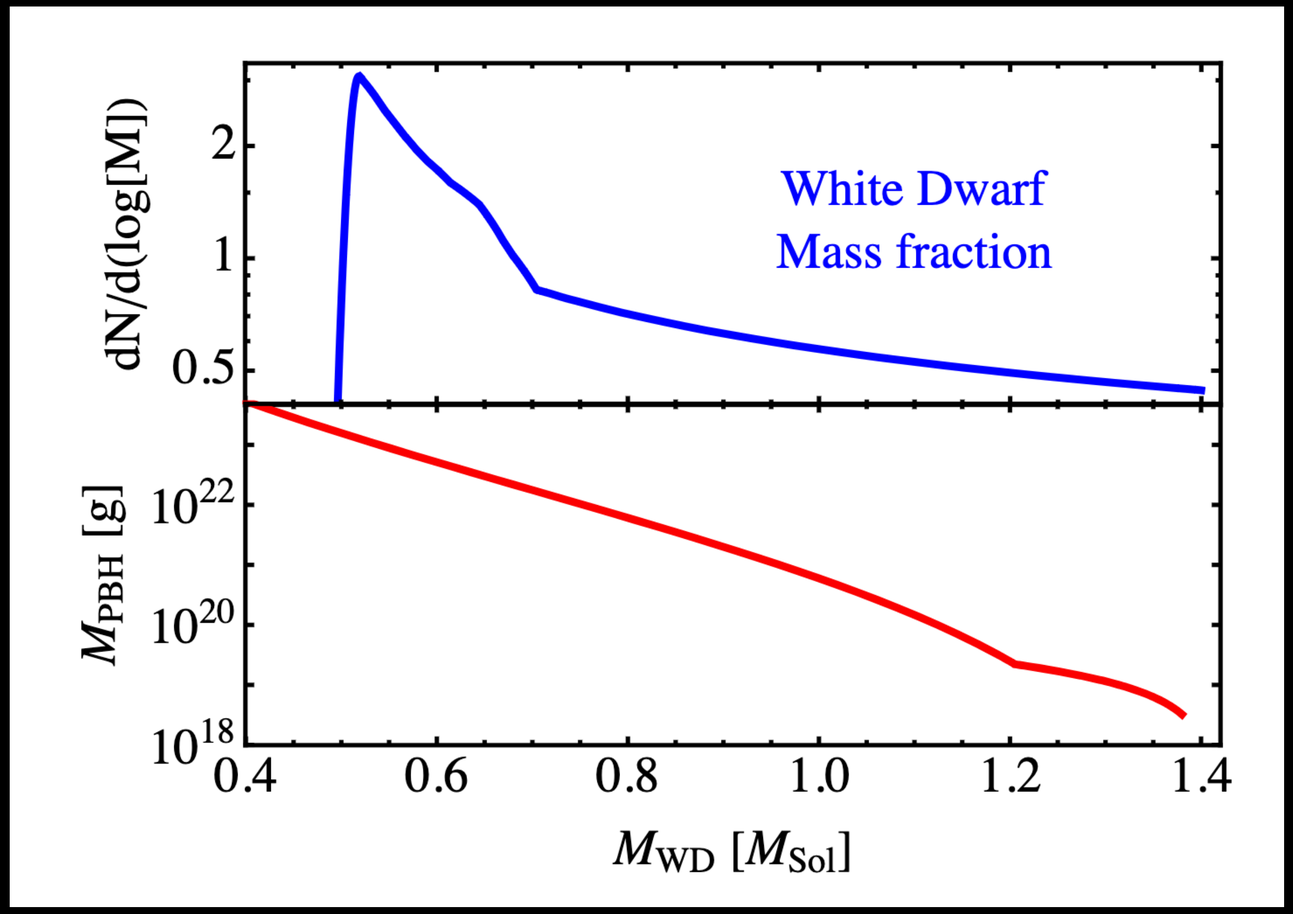
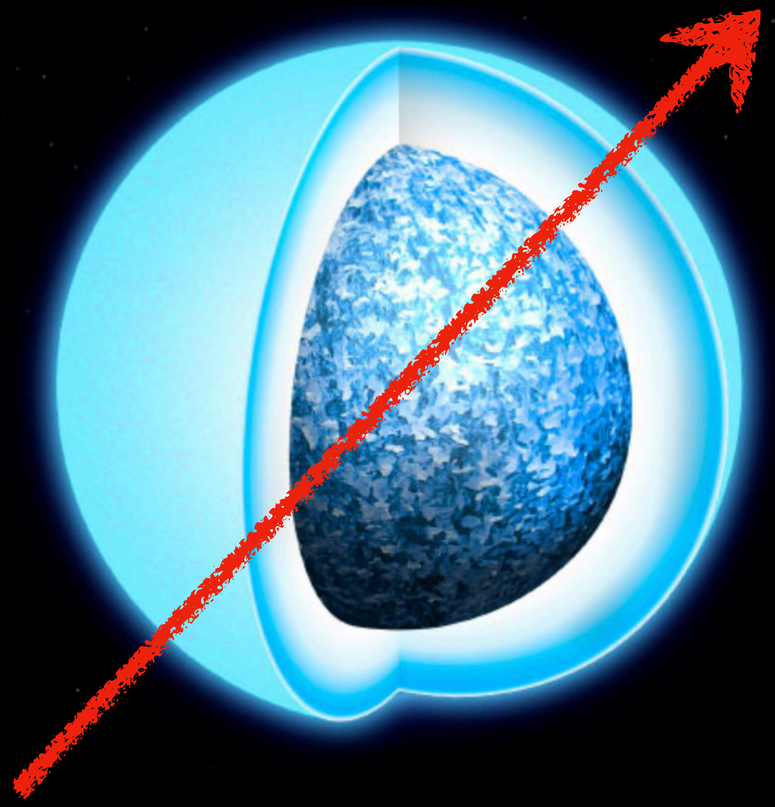
Dark Matter Triggered Supernova





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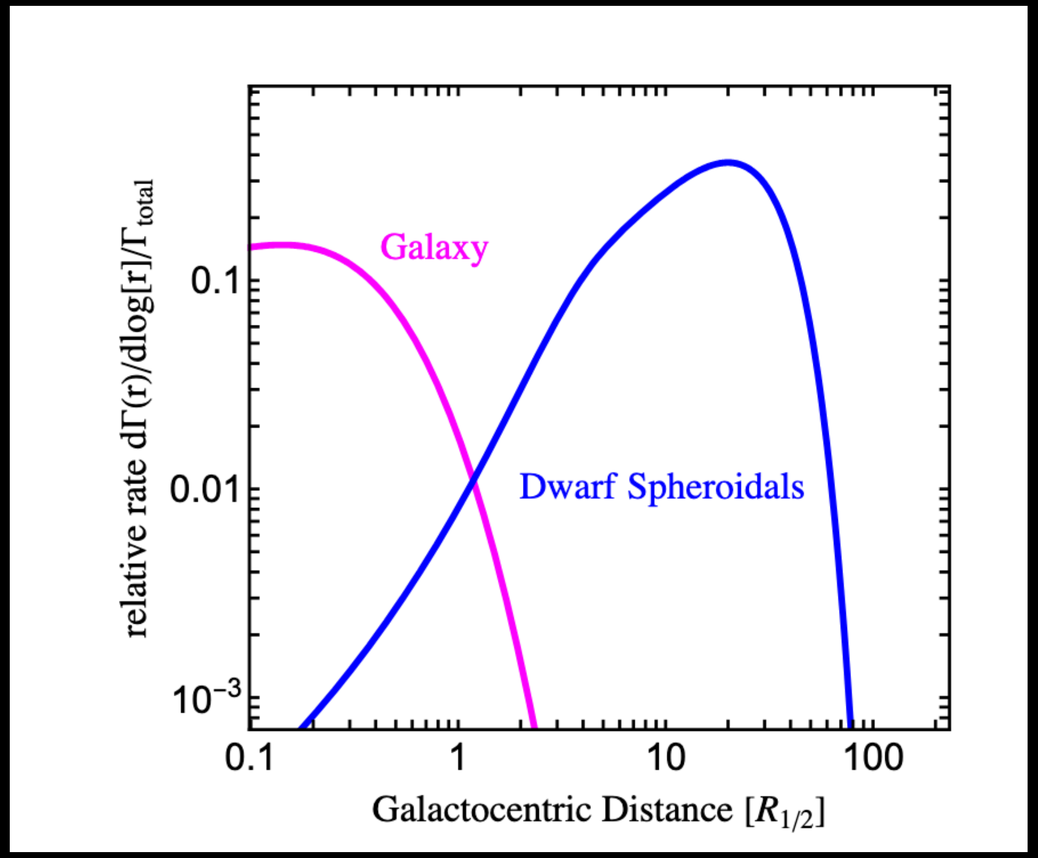
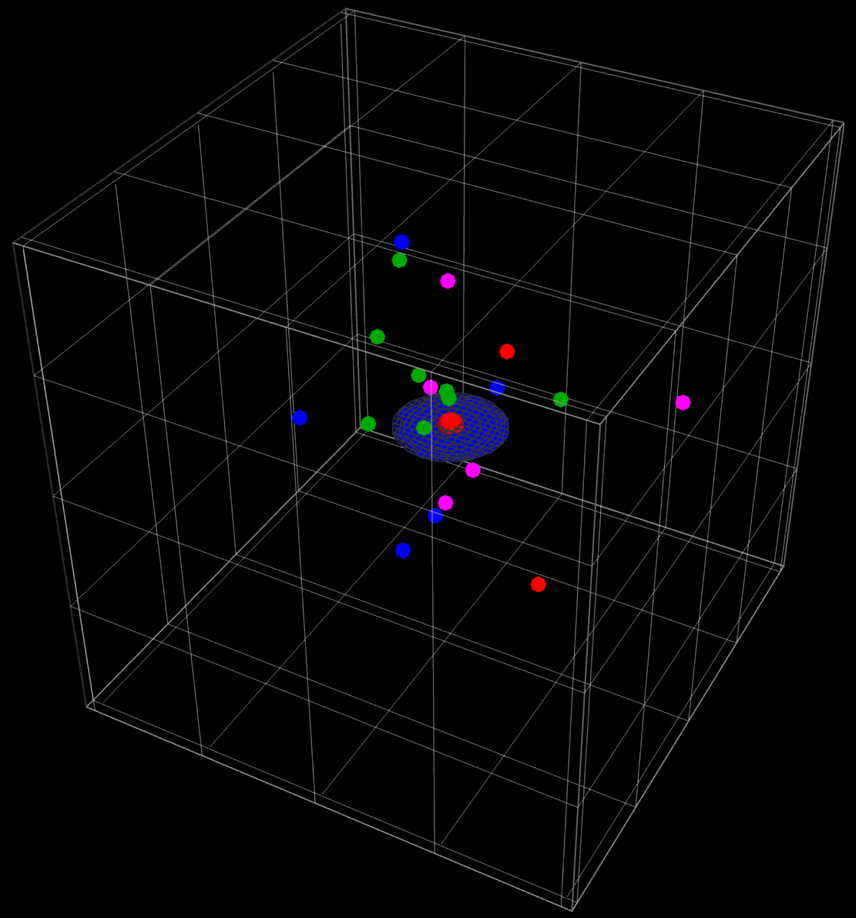
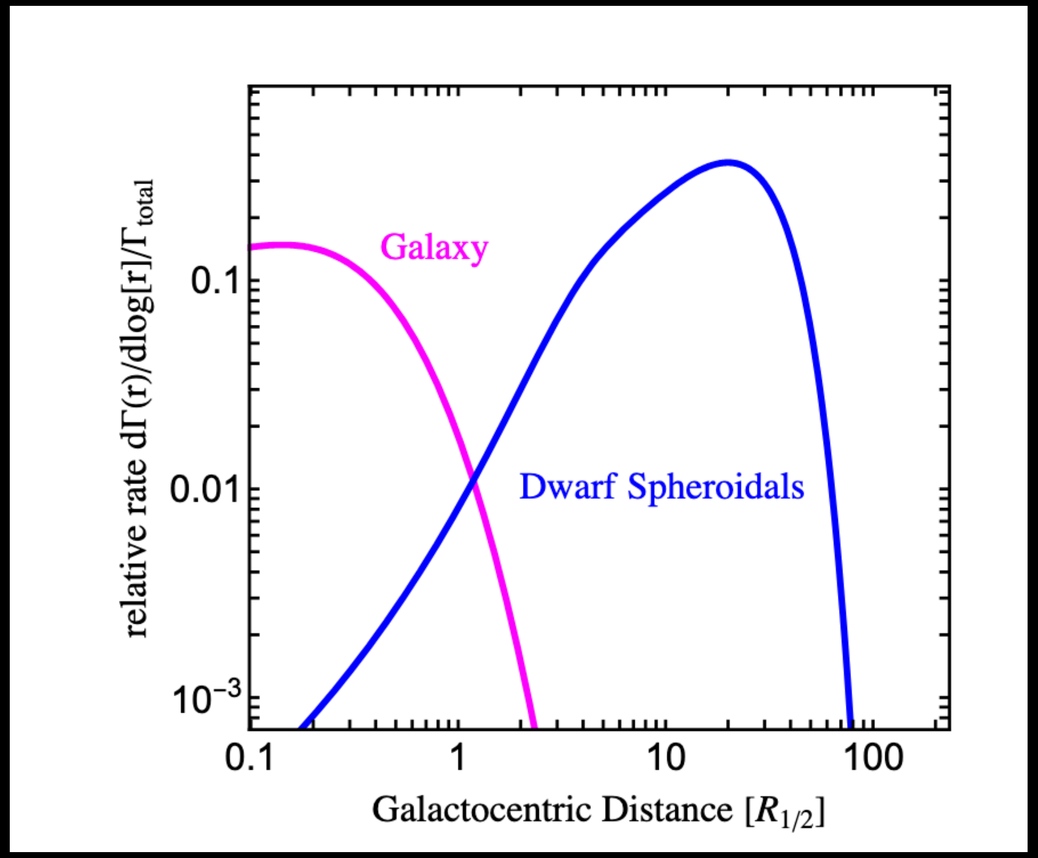
Spacial Distribution

Distribution in Distant Galaxies

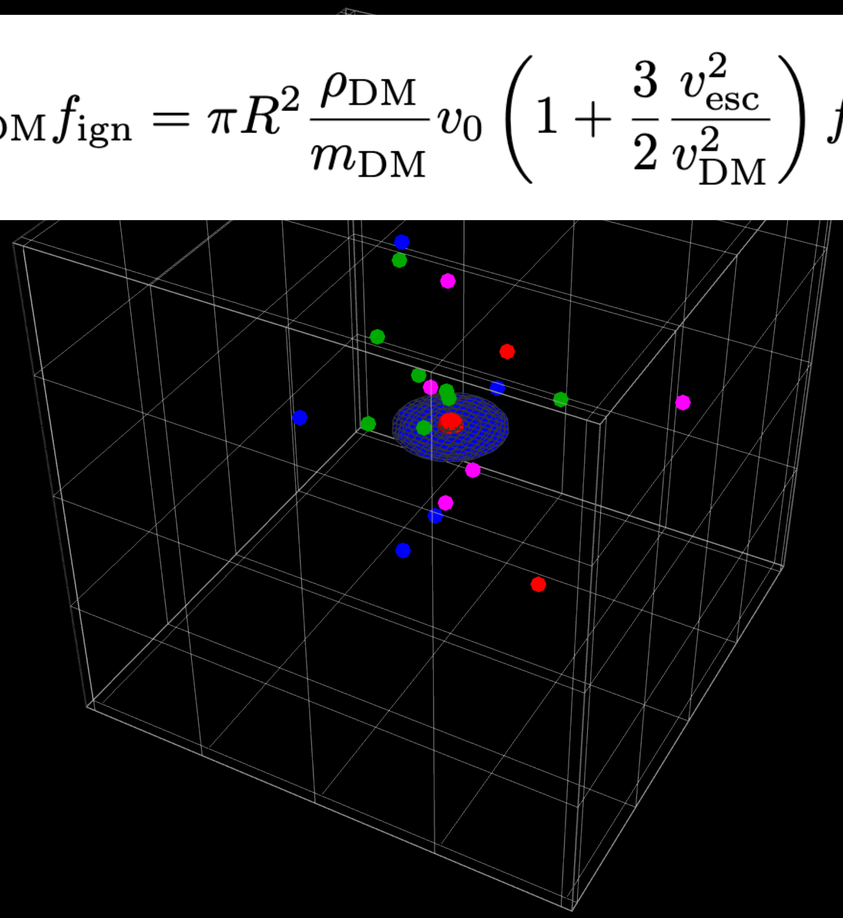




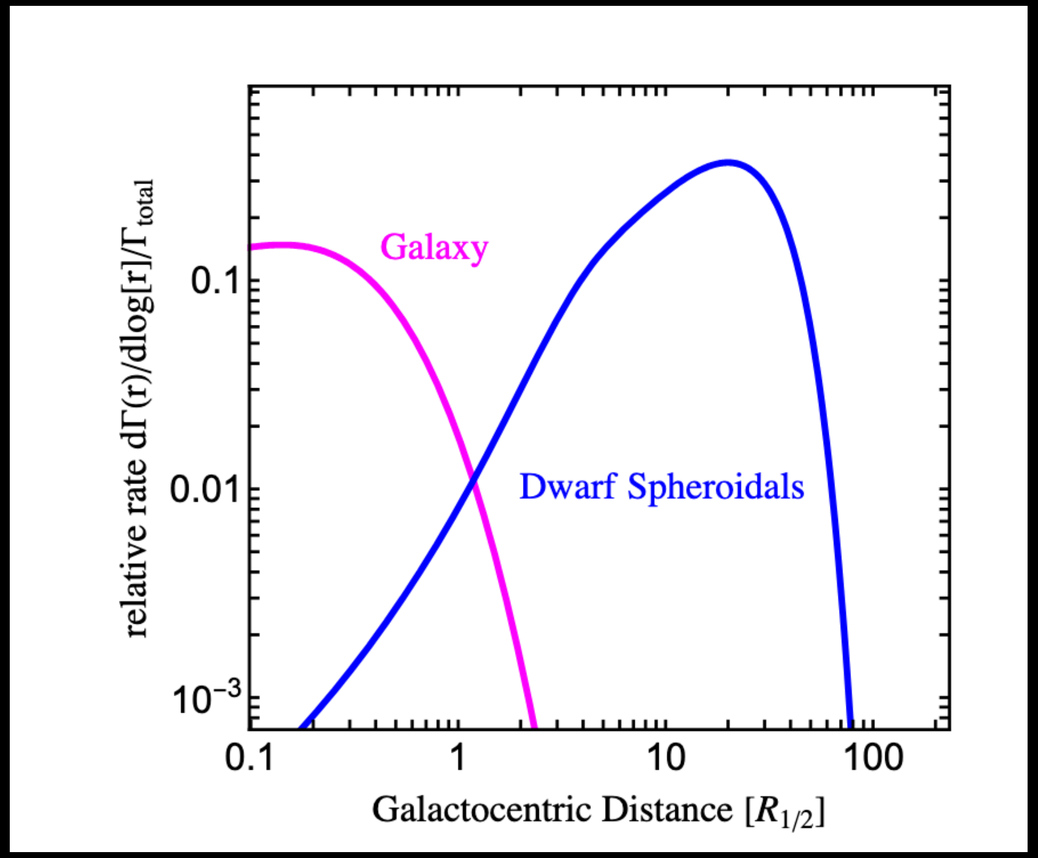
Distribution in Distant Galaxies

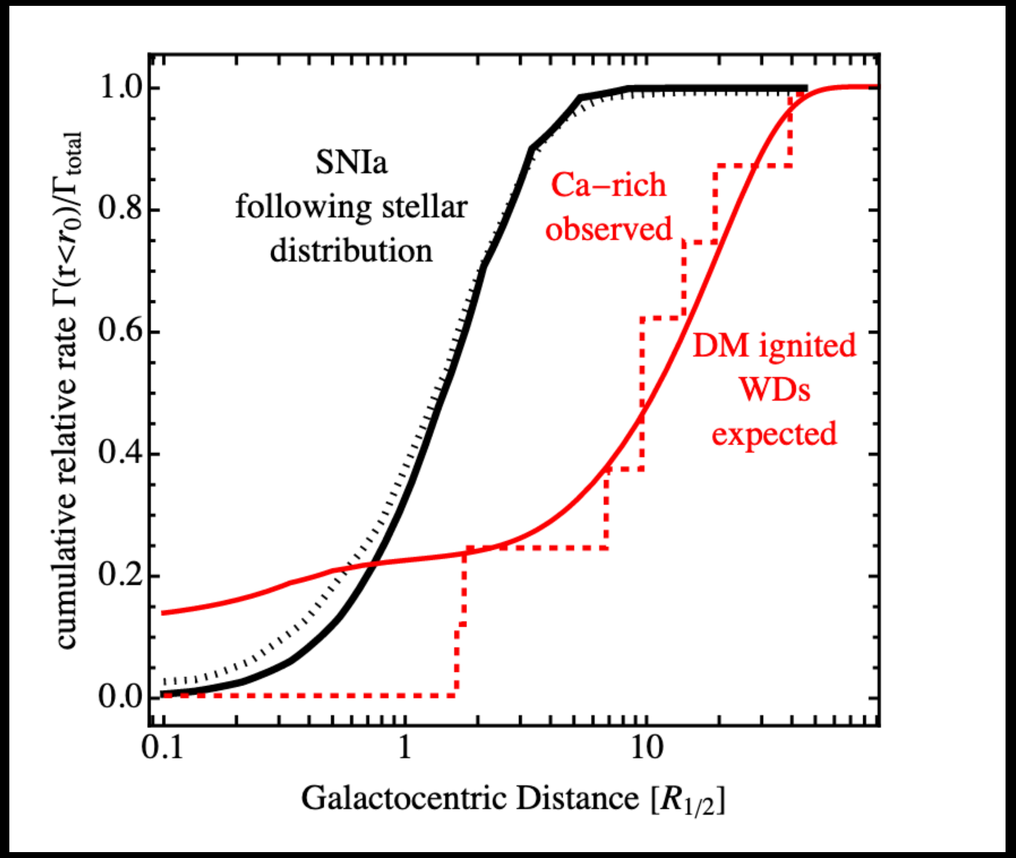


$$\Gamma_{\rm ign} = \phi_{\rm DM} f_{\rm ign} = \pi R^2 \frac{\rho_{\rm DM}}{m_{\rm DM}} v_0 \left(1 + \frac{3}{2}\frac{v_{\rm esc}^2}{v_{\rm DM}^2}\right) f_{\rm ign}$$



Fit to the Observational Data





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PBH Parameter Space

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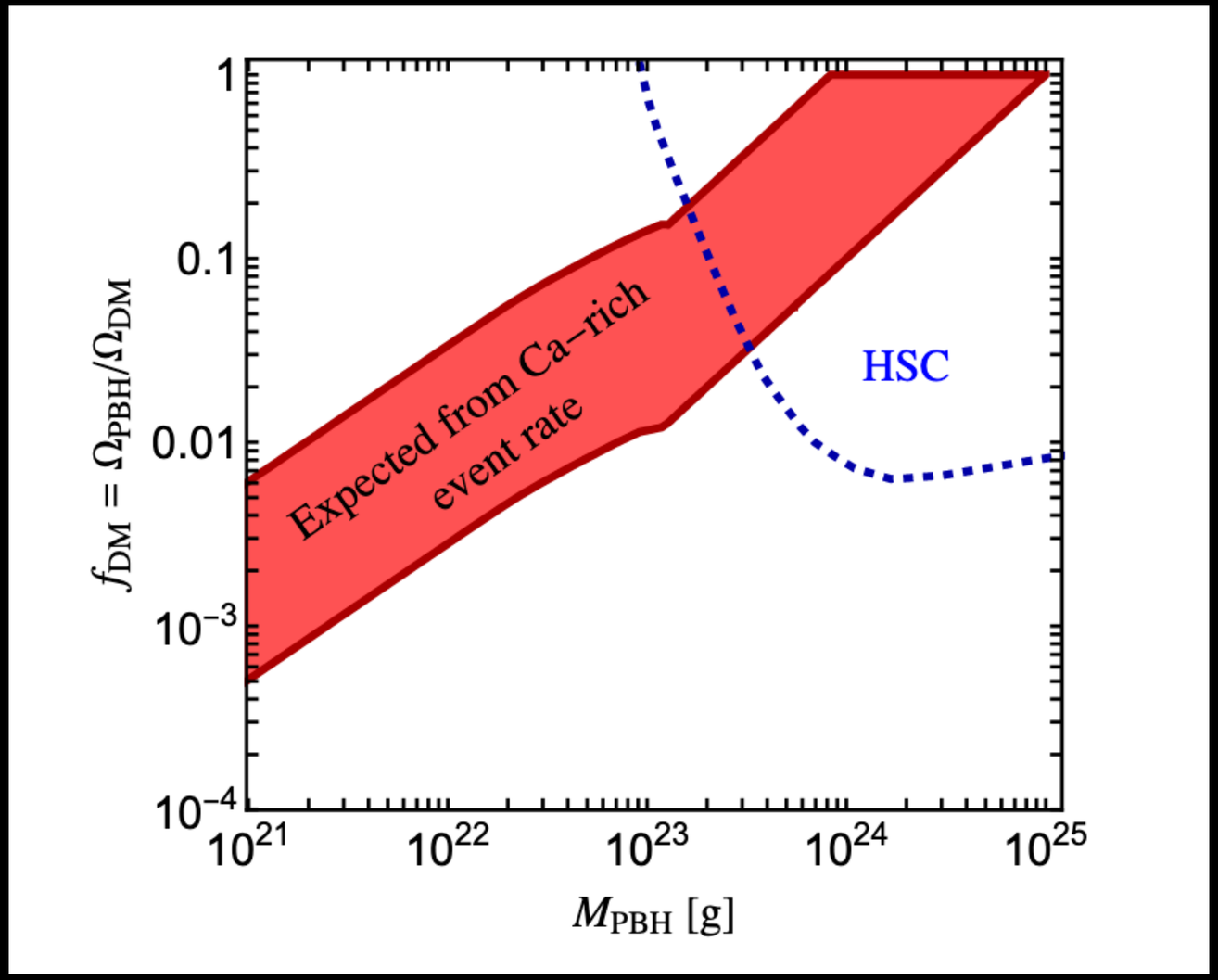
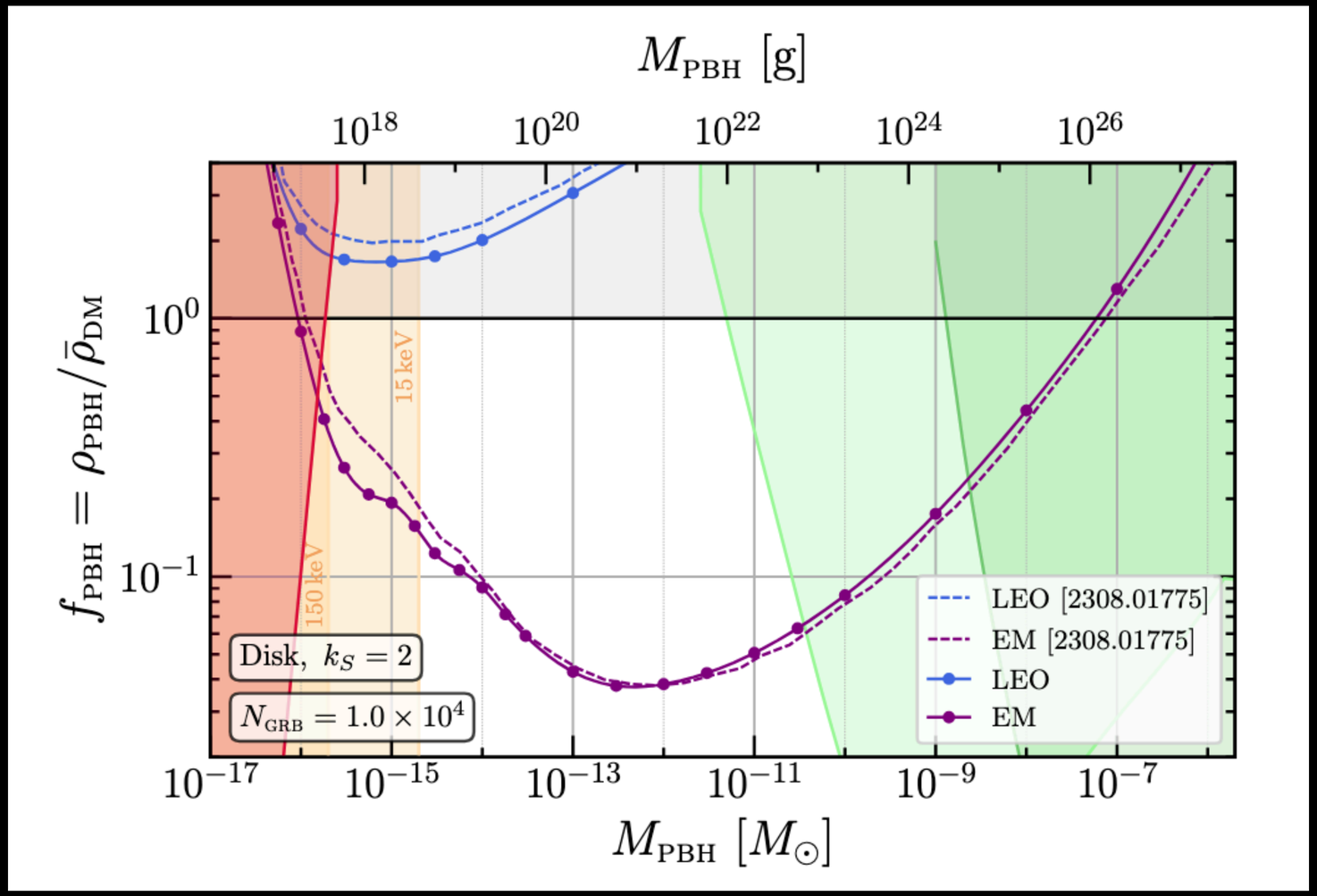
Minimal Benchmark Model PBHs



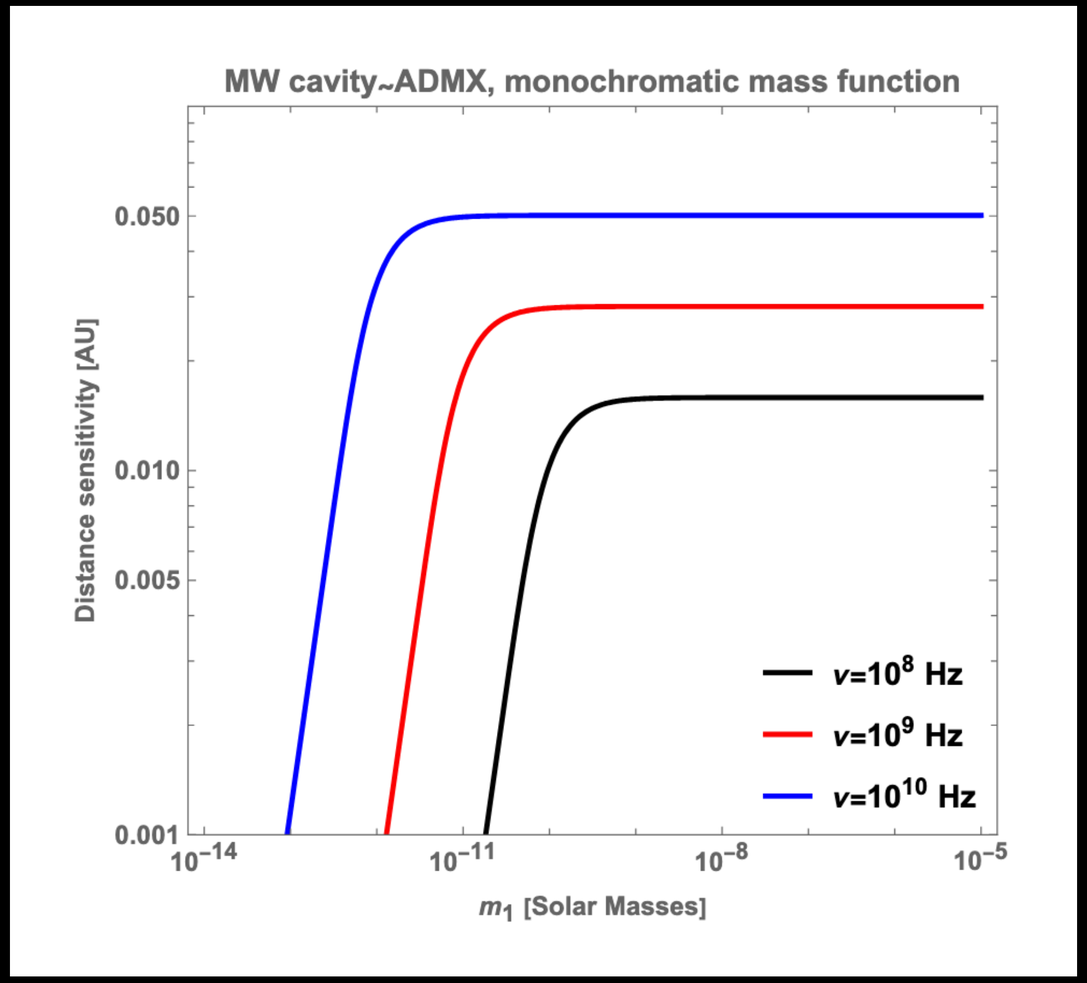
Other Search Strategies

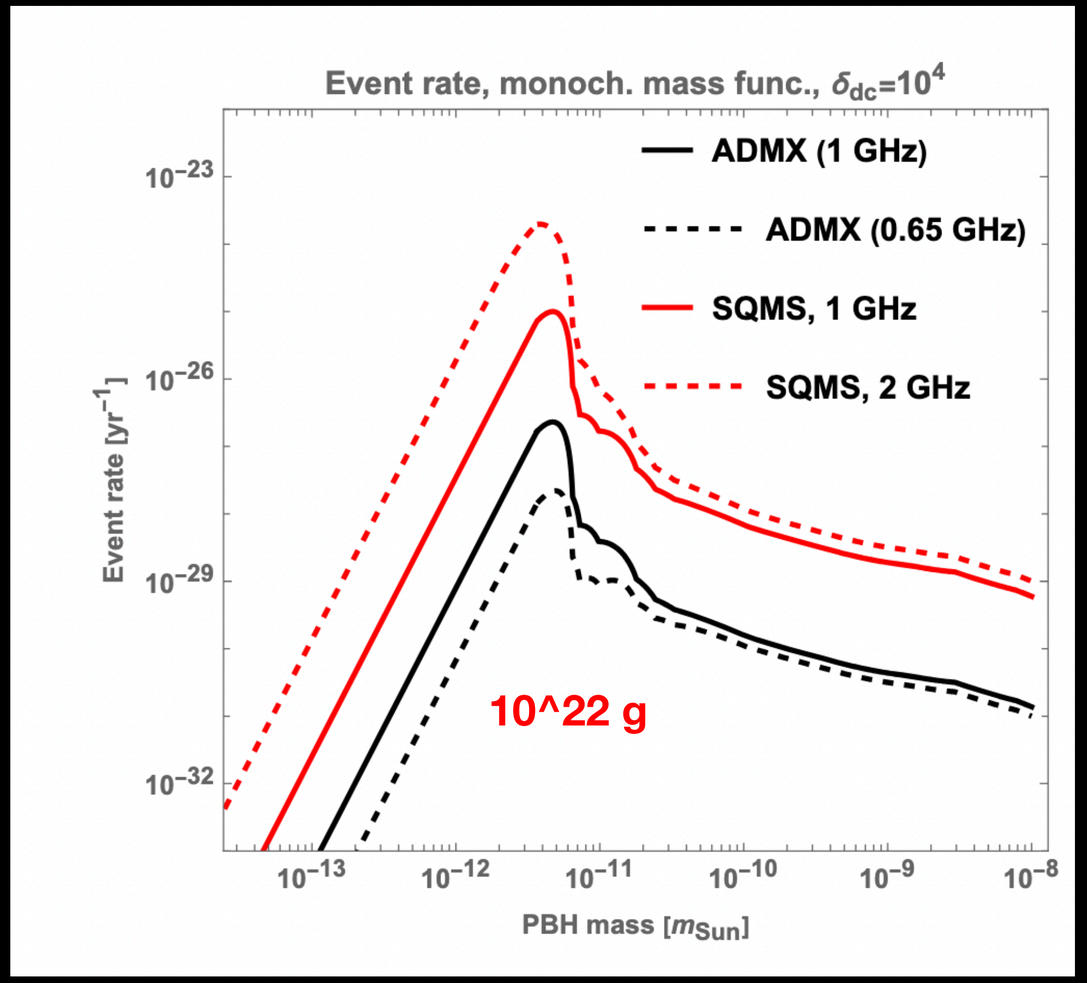
Picolensing of GRBs



M. Feddeke and S. Sibiryakov
2411.12947

Astroid Masses Maximise the GW Signal





Profumo et al. 2410.15400

Quantum Initiatives at UoL

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UNIVERSITY OF LIVERPOOL

Development & Exploitation of SQUIDs

Research projects involving Superconducting Quantum Interference Devices (SQUIDS):

- Successfully developed very thin (< 10 nm) Nb superconducting nanowires and films for sensor fabrication and single photon detectors

  Electrical Engineering & CMP – Liam O'Brien

- Development of co-planar superconducting waveguides and resonators terminating on a SQUID to create a tuneable 'mirror' for highly sensitive quantum photonics experiments
  - Collaboration of UoL silicon-based quantum sensor experts, quantum theorists and international lab (FBK – Trento) for development and reproducibility

  J Tinsley, J Smirnov, G Casse, M D'Onofrio

- FLASH experiment to search for QCD axions using resonant microwave cavities P Beltrame

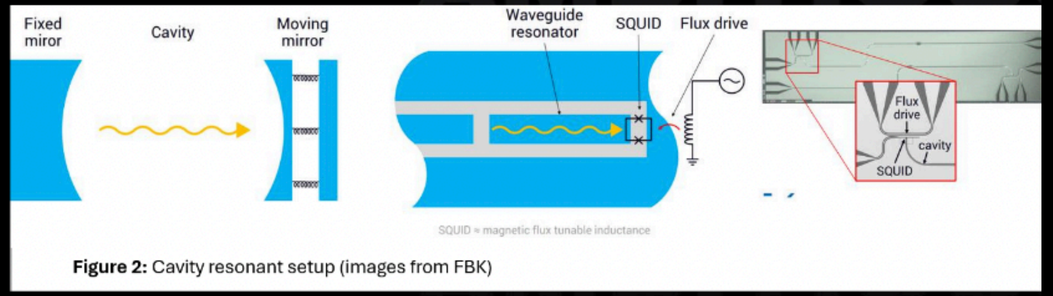
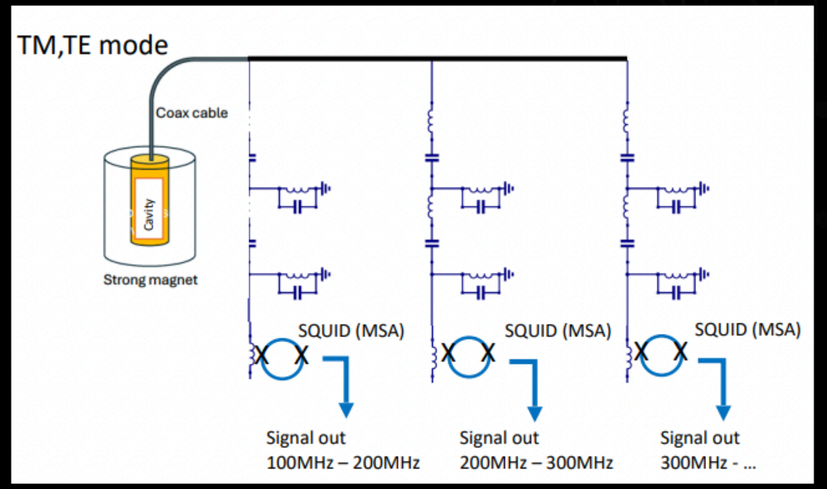


Figure 2: Cavity resonant setup (images from FBK)



Thanks to J. Tinsley

Areas of Overlap

1. Astrophysics - Novel signals indicate PBHs in the 10^{22}--10^{24} g mass window.

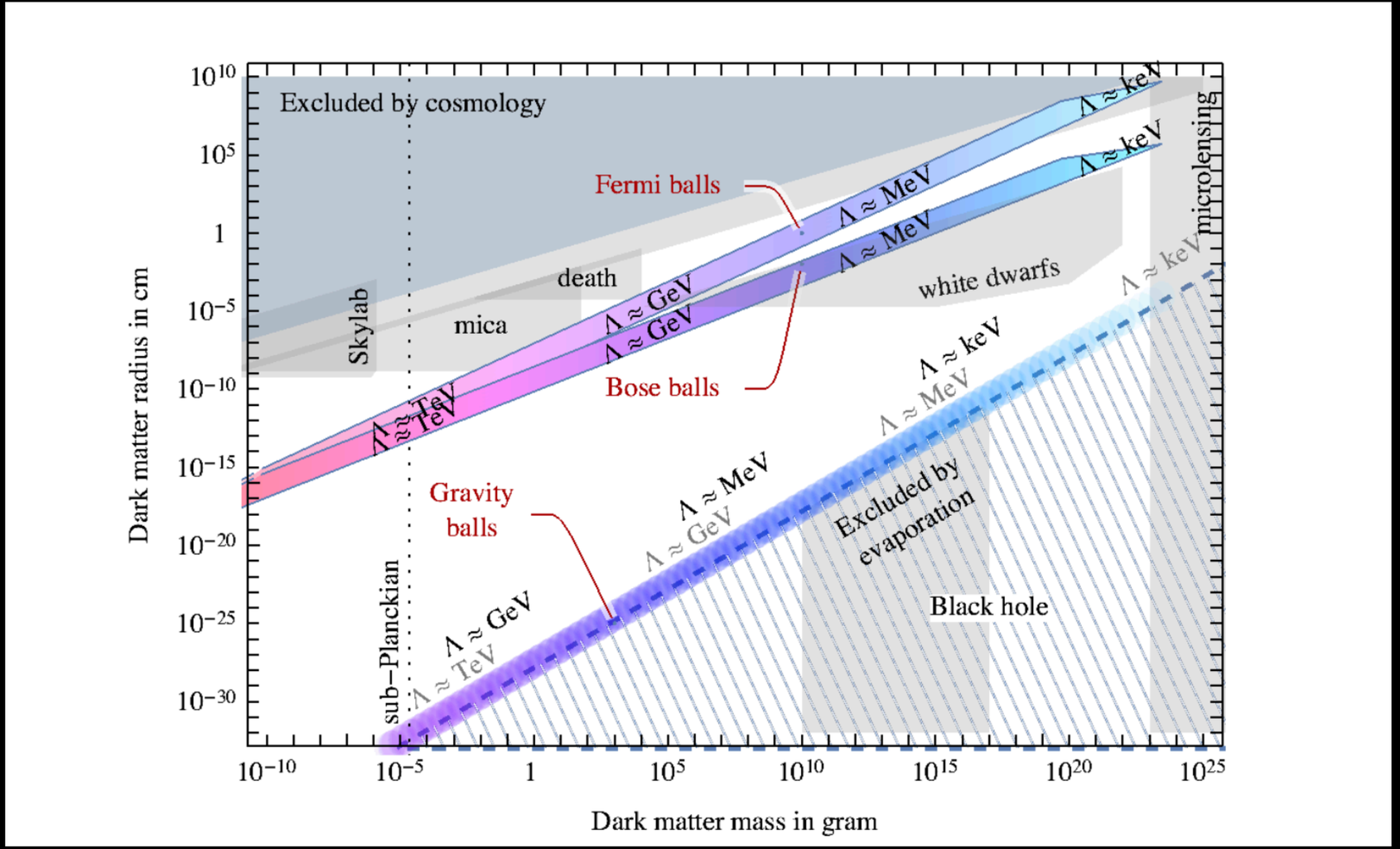
2. Quantum Sensors & Cryogenics - Development of ultra-thin Nb superconducting nanowires and coplanar resonators. - Expertise in SQUID-based low-noise readouts and cryogenic quantum sensing (FLASH, QUEST-DMC). - Technological overlap with GravNet's needs for GHz-range resonant cavity detectors.

3. Quantum Interferometry & Metrology - Active contributions to AION/MAGIS atom interferometers. - Local Rb interferometry labs and proposed TVLBAI precision sensor. - Relevant expertise in baseline synchronisation, low-noise isolation, and quantum readout systems.

4. Quantum Computing & AI - Leading efforts in quantum simulations of particle physics, including neutrino interactions. - Quantum Machine Learning (QML) applied to signal detection and anomaly identification. - Opportunities to develop PBH merger classifiers or background rejection algorithms.

Thanks

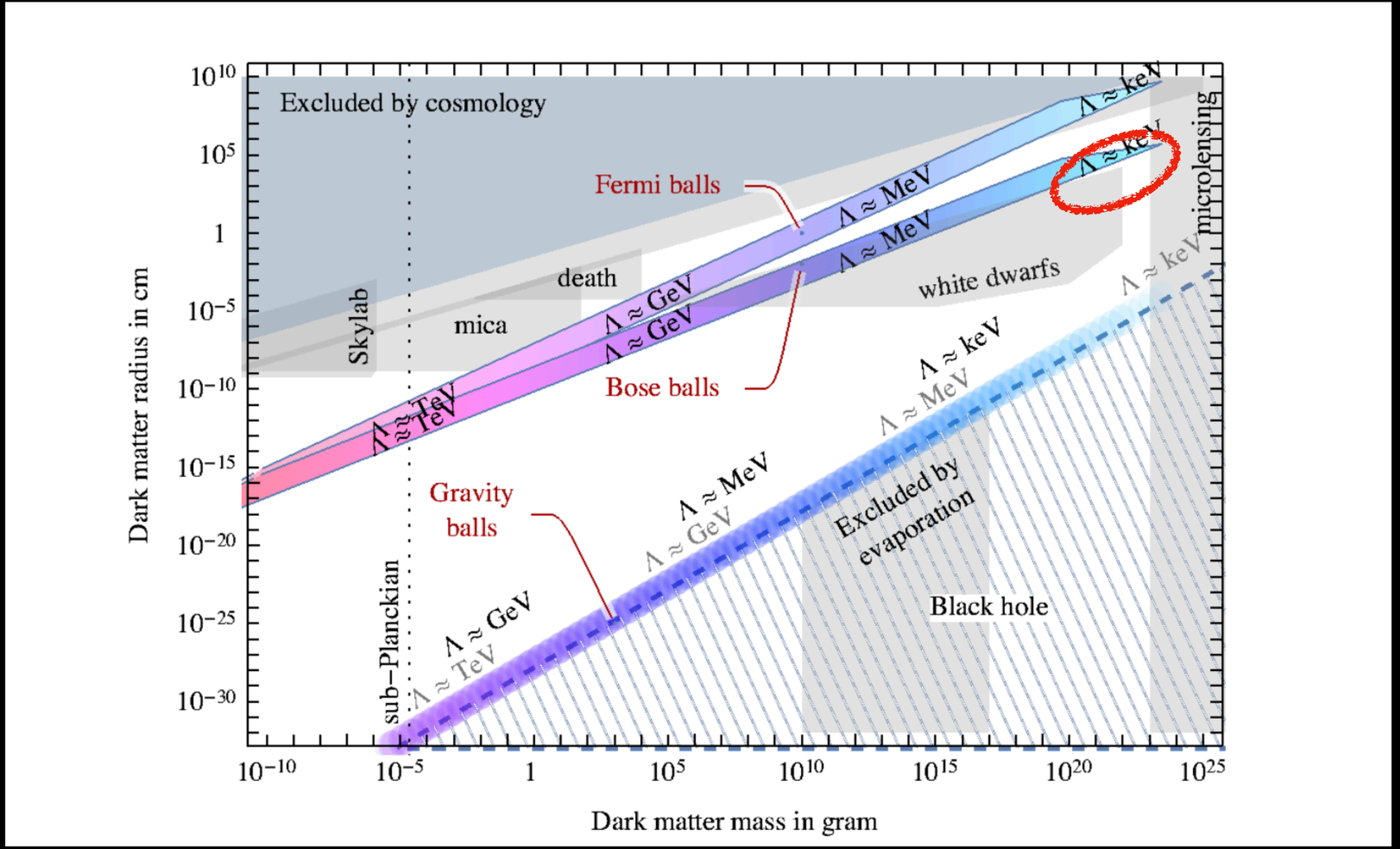
Compact Objects from Phase Transitions



2105.02840:
Gross et al.

For PBHs from confinement see:
2108.09471:
Dvali et al.

Compact Objects from Phase Transitions



2105.02840:
Gross et al.

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Rich Scenario Space to Explore